

**THE OCTOBER 1989 SURVEY OF THE  
LINAC TO BOOSTER TRANSPORT BEAM LINE**

**BOOSTER TECHNICAL NOTE  
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Introduction

The Linac to Booster transport beam line was surveyed on October 9, 1989. Coordinates were measured with respect to the AGS geodetic grid, for the location of the apex of each proton injection line magnet. It was found that coordinates reported prior to this survey needed some correction.

In particular, it was found that the apex of the kicker magnet PIK1 installed in the HEBT line was displaced approximately four inches downstream from the position used in calculating beamline component positions in Table 4-1 of the Booster Design Manual, Revision 1, 1988. Based on the October 9, 1989 Survey measurements, the positions of the beam components along the line were re-calculated, and the line was installed. The installation took into account the actual location of kicker magnet PIK1, and was subject to the constraints that the line endpoint, at P1QDS, remained fixed and that the bending angles in the four dipoles were held equal to one another.

This note is intended as an update to Table 4-1 of the Booster Design Manual, Revision 1, October 1988, for the AGS Booster Project. Corrected magnet apex coordinates are given for the injection line magnets. Corrected bend angles are also given.

Description Of The Injection Line

The Booster Injection Line components are described in section 4.1 of the Booster Design Manual [1]. The locations of the proton injection line elements are listed in Table 4-1 as a tabulation of coordinates of the apexes of the injection line magnets. Apex coordinates are given in Booster, AGS, and BNL coordinate reference systems in Table 4-1, page 4-3.

A plan view diagram showing the injection line magnets is given in Figure 4-3, page 4-4 of the Booster Design Manual.

Coordinate transformations between the three coordinate reference systems are given by the following relations [2]:

I. AGS Grid to Booster Grid

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$$X \text{ [Booster, Inches]} = E \text{ [AGS, Inches]} - EO \text{ [AGS, Inches]}$$

$$Y \text{ [Booster, Inches]} = N \text{ [AGS, Inches]} - NO \text{ [AGS, Inches]} \text{ where}$$

$$EO \text{ [AGS, Inches]} = 1,448.88, \quad NO \text{ [AGS, Inches]} = 15,459.36,$$

and

$$X \text{ [Booster, Meters]} = (0.02540) \times X \text{ [Booster, Inches]},$$

$$Y \text{ [Booster, Meters]} = (0.02450) \times Y \text{ [Booster, Inches]},$$

$$X \text{ [Booster, Feet]} = (1 / 12) \times X \text{ [Booster, Inches]},$$

$$Y \text{ [Booster, Feet]} = (1 / 12) \times Y \text{ [Booster, Inches]}.$$

II. Booster Grid to BNL Grid

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$$E \text{ [BNL, Feet]} = EO \text{ [BNL, Feet]} + X \text{ [Booster, Feet]}$$

$$N \text{ [BNL, Feet]} = NO \text{ [BNL, Feet]} + Y \text{ [Booster, Feet]}$$

$$EO \text{ [BNL, Feet]} = 98,517.19 \quad NO \text{ [BNL, Feet]} = 102,438.28.$$

We note that the origins of these grids are not the same.

### The October 1989 Survey

The survey data for the October 1989 survey of the Linac to Booster Transport Line are stored in File B:LTB91989.100 of the BNL Survey Group.

The surveyors were Francis X. Karl, Donald L. Kazmark Jr., Joseph C. Roeklein and John S. Sullivan.

The proton injection line magnets are designated by the following symbols:

|      |   |
|------|---|
| PID  | Proton Injection Dipole                 |
| PIQF | Proton Injection Quadrupole, Focusing   |
| PIQD | Proton Injection Quadrupole, Defocusing |
| PIK  | Proton Injection Kicker                 |

The survey results are given in the following tables.

Table 1.  
Location Of The Proton Injection Line Elements.

| Survey<br>Point<br>Number<br>===== | Injection<br>Element<br>Number<br>===== | Magnet<br>Element<br>Name<br>===== | Location Of Magnet Apex<br>[AGS, Inches] |            |
|------------------------------------|---|------------------------------------|--|------------|
|                                    |   |                                    | E  | N          |
| 11                                 | 1                                       | PIKI                               | -658.9432                                | 14516.9353 |
| 42                                 | 2                                       | PIQF1                              | -502.3375                                | 14417.9046 |
| 43                                 | 3                                       | PIQD1                              | -459.0797                                | 14390.5502 |
| 44                                 | 4                                       | PIQFE                              | -415.8219                                | 14363.1959 |
| 45                                 | 5                                       | PIQDE                              | -372.5642                                | 14335.8415 |
| 46                                 | 6                                       | PIQF3                              | -329.3064                                | 14308.4872 |
| 47                                 | 7                                       | PID1                               | -262.1897                                | 14266.0455 |
| 48                                 | 8                                       | PIDE                               | -197.8758                                | 14265.1588 |
| 49                                 | 9                                       | PIQF4                              | -160.0765                                | 14287.6274 |
| 50                                 | 10                                      | PID3                               | -122.2772                                | 14310.0960 |
| 51                                 | 11                                      | PIQFS                              | -101.7998                                | 14349.0100 |
| 52                                 | 12                                      | PID4                               | -18.5660                                 | 14507.1830 |
| 53                                 | 13                                      | PIQF6                              | -26.6211                                 | 14629.6364 |
| 54                                 | 14                                      | PIQD3                              | -29.9805                                 | 14680.7070 |
| 55                                 | 15                                      | PIQF7                              | -35.9242                                 | 14771.0627 |
| 56                                 | 16                                      | PIQD4                              | -39.2836                                 | 14822.1334 |
| 57                                 | 17                                      | PIQF8                              | -45.2272                                 | 14912.4881 |
| 98                                 | 18                                      | PIQD5                              | -50.6540                                 | 14994.9880 |

Table E.

## Spacings Between Injection Line Elements

| From Element<br>Number | To Element<br>Number | Distance [Inches]<br>Apex to Apex |
|------------------------|----------------------|-----------------------------------|
| End Of Linac<br>Tank 9 | 1                    | 723.125                           |
| 2                      | 3                    | 185.290                           |
| 3                      | 4                    | 51.181                            |
| 4                      | 5                    | 51.181                            |
| 5                      | 6                    | 51.181                            |
| 6                      | 7                    | 79.410                            |
| 7                      | 8                    | 64.320                            |
| 8                      | 9                    | 43.973                            |
| 9                      | 10                   | 43.973                            |
| 10                     | 11                   | 43.973                            |
| 11                     | 12                   | 178.736                           |
| 12                     | 13                   | 122.718                           |
| 13                     | 14                   | 51.181                            |
| 14                     | 15                   | 90.551                            |
| 15                     | 16                   | 51.181                            |
| 16                     | 17                   | 90.550                            |
| 17                     | 18                   | 82.678                            |

Table 3.  
 Bend Angles Of Successive Sections Of The  
 Linac To Booster Transport Beam Line

| Linear Section<br>Between Apices | Deflection<br>Deg/Min/Sec | From Linear Section |
|----------------------------------|---------------------------|---------------------|
| 1 To 7                           | 7 / 41 / 33.5             | Linac Beam Exit     |
| 7 To 8                           | 31 / 31 / 3.7             | 1 To 7              |
| 8 To 10                          | 31 / 31 / 4.0             | 7 To 8              |
| 10 To 12                         | 31 / 31 / 4.0             | 8 To 10             |
| 12 To 18                         | 31 / 31 / 4.0             | 10 To 12            |

TABLE 4 Location of the proton injection line elements.

## Location of Proton Injection Line Elements

| No. | Name   | Booster Coord. |          | AGS Coord. |            |
|-----|--------|----------------|----------|------------|------------|
|     |        | x (m)          | y (m)    | E (in)     | N (in)     |
| 1   | PIR1   | -45.9187       | -23.9376 | -658.9432  | 14516.9353 |
| 2   | PIQF1  | -41.9409       | -26.4530 | -502.3375  | 14417.9046 |
| 3   | PIQD1  | -40.8422       | -27.1478 | -459.0797  | 14390.5502 |
| 4   | PIQF2  | -39.7434       | -27.8426 | -415.8219  | 14363.1959 |
| 5   | PIQDF2 | -38.6447       | -28.5374 | -372.5642  | 14335.8415 |
| 6   | PIQF3  | -37.5441       | -29.2322 | -329.3064  | 14308.4672 |
| 7   | PID1   | -35.8412       | -30.3102 | -262.1897  | 14266.0455 |
| 8   | PID2   | -34.2076       | -30.3327 | -197.8758  | 14265.1588 |
| 9   | PIQF4  | -33.2475       | -29.7620 | -160.0765  | 14287.6274 |
| 10  | PID3   | -32.2874       | -29.1922 | -122.2772  | 14310.0960 |
| 11  | PIQF5  | -31.7673       | -28.2029 | -101.7998  | 14349.0100 |
| 12  | PID4   | -29.6531       | -24.1853 | -18.5660   | 14507.1830 |
| 13  | PIQF6  | -29.8577       | -21.0750 | -26.6211   | 14629.6364 |
| 14  | PIQD3  | -29.9431       | -19.7778 | -29.9805   | 14680.7070 |
| 15  | PIQF7  | -30.0940       | -17.4828 | -35.9242   | 14771.0627 |
| 16  | PIQD4  | -30.1794       | -16.1856 | -39.2836   | 14822.1334 |
| 17  | PIQF8  | -30.3303       | -13.8905 | -45.2272   | 14912.4881 |
| 18  | PIQD5  | -30.4682       | -11.7950 | -50.6540   | 14994.9880 |

## References

1. Booster Design Manual, AGS Booster Project, Accelerator Development Department, Brookhaven National Laboratory, Upton NY, Revision 1 , October 1988.
2. Z. Parsa, AGS Booster Geometry and Coordinates, Booster Technical Note No. 100, Accelerator Development Department, Brookhaven National Laboratory, November 1987.